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Sustainable cultivation of olive trees by reusing olive mill wastes after effective co-composting treatment processes

APOSTOLOS VLYSSIDES, NICOLETTE VAN DER SMISSEN, ELLI MARIA BARAMPOUTI, SOFIA MAI[1]

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Abstract

Olive oil production is associated with extremely polluting byproducts causing serious environmental problems in most Mediterranean countries. These highly polluting residues are currently disposed of in the soil, rivers or lakes or where treatment methods have been applied, they were proven insufficient or non-feasible under the Greek situation. On the other hand strict EU environmental legislation could force the olive oil mills to close unless a viable and environmentally sound solution is adopted. This paper reports on an integrated viable solution to the olive mill waste problem. The method involves the olive oil removal from wastewater, their detoxification by Fenton oxidation reactions and following their utilization by biological treatment methods (anaerobic digestion and co-composting).

Introduction

All olives' treatment processes (olives, olive oil, olive wooden residue) produce liquid and solid wastes which are considered toxic. The treatment of these wastes by using conventional technologies (aerobic/anaerobic biological treatment, incineration, gasification etc) proved to be neither technically nor cost effective (McNamara et al. 2008, Zagklis et al. 2013). This fact threats the olive oil production by complete cease due to the serious environmental problems caused. The main problems in the treatment of Olive mill wastewater (OMWW) are the following:

- OMWW toxicity mainly due to the high phenolic compounds content (16g/L)
- OMWW high organic load (120g/L COD)
- The seasonal operation of olive mills (3 months/year)
- The olive mills capacity (small, family run companies) (Goula and Adamopoulos 2013, Justino et al. 2012, Pierantozzi et al. 2012).

In the problems mentioned before, the very tight options for environmental strategy of waste management due to economical reasons should be added. Consequently, conventional technologies even if they were technologically effective, have proved to be economically ineffective.

Material and methods

The proposed technology (Figure 1) includes the olive oil removal from wastewater, their detoxification by Fenton oxidation reactions (Vlyssides et al. 2004) and following their utilization by biological treatment methods. The latter is achieved by the implementation of anaerobic digestion process on the oxidized wastewater and the consequent methane production and by co-composting the oxidized or/and anaerobic digested wastewater with solid wastes (olive mill wooden residue, leaves, branches etc), leading to the production of a high quality soil conditioner. The biogas produced could be utilized for in situ thermal and electrical energy production. The two biological processes used (anaerobic digestion and composting) are ideally combined, since the anaerobic digested wastewater is fully used in the composting process, while the excess thermal energy produced by biogas utilization can accelerate the aerobic biological processes resulting in a high quality biological fertilizer (Vlyssides et al. 2009).

[1] School of Chemical Engineering, National Technical University of Athens, Greece, eMail: avlys@tee.gr

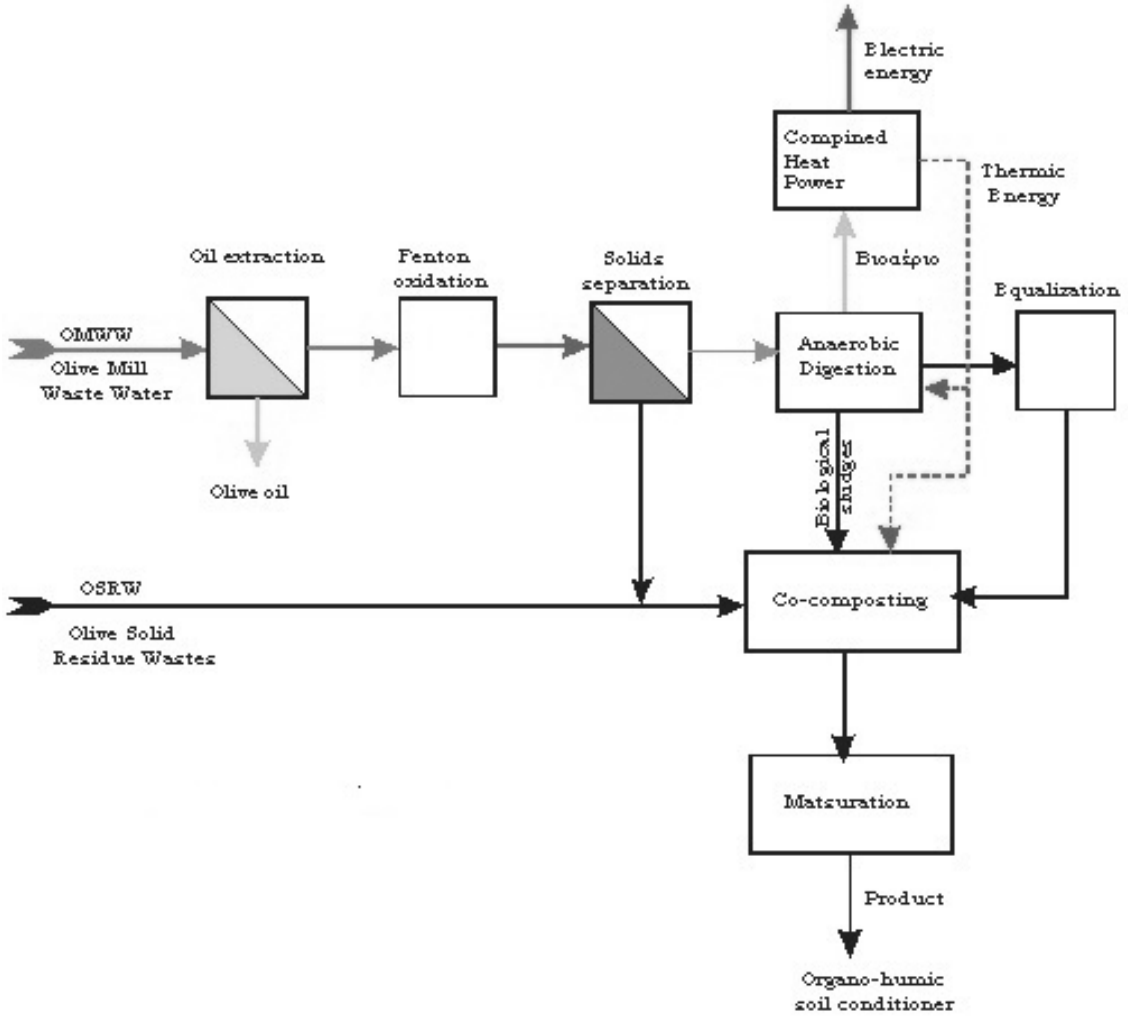

Figure 1. Recent development of the innovation

Results

Olive oil removal from wastewater is a stage of crucial importance. The produced oil could be used as raw material for biodiesel. Up to 2020, 20% of transportation fuels should be replaced by biofuels. Oils for biodiesel production are not available in Greece. In 2020, the need for oils would be up to 60000 tons per year. If there is no action in this direction, this amount should be imported. If the proposed innovation is used as a national solution, the potential oil production could be averagely 60000 tons per year, which means that Greece could meet the biofuel need without any import. Apart from this, oil removal helps essentially the co-composting process, because grease and oil are inhibitory factors in the composting ecosystem development.

By the application of the proposed technique all the nutrients (K, P, N), which have been removed from the cultivation soil, could be recycled by using the produced biological fertilizer (Vlyssides et al. 2012). This way, the sustainability of olive trees cultivation and of olive oil production is rendered feasible and the whole proposed technique could be effective. The soil conditioner is produced exclusively from plants, and it has been proved to be ideal for the biological cultivation of many products such as citrus, vineyards, aromatic herbals, asparagus etc.

The proposed technology is effective and simple to be implemented. Wastewater that has derived either from two or three phase olive mill could be treated. This technology can be implemented either in one olive mill scale or in centralized wastewater treatment plants. The proposed technology can not only effectively face the serious environmental problems caused by olive mill wastewater disposal, but it poses new perspectives in olive trees cultivation and olive oil and its by-products market.

Discussion

According to the European commission, in 2013 the financial aid of olive oil production will cease and after 2012 the olive trees cultivation and olive oil production could not proceed if the environmental problems are not addressed. In this context, the proposed technology could give the necessary development prospective in olive oil producing countries, given that it can face all the problems both environmental and economical. This innovation is environmentally integrated, since all wastes derive from olive oil production are treated effectively. The wastewater is co-composted with solid wastes (pulp, olive stone residue, olive trees leaves and branches) producing an organo-humic soil conditioner, a marketable product. If this product is used in olive trees cultivation, there is no need for additional chemical fertilizers use. By this way, the sustainable olive trees cultivation is promoted and the olive oil production becomes a "clean" technology. Additionally, the produced olives and olive oil could be considered biological products and consequently their price is elevated and the need for external finance is eliminated. It can be concluded that this innovation could promote green development in Greece, where the olive trees cultivation dating 5000 years ago. The whole innovation is feasible, because it is simple in its application with standard good results. Its economical effectiveness could be insured by the producers themselves.

This technology has already been implemented in 5 olive mills in Greece with very promising results and can be a promising alternative either for all the olive mill owners or for olive trees and generally biological products cultivators.

Suggestions to tackle with the future challenges of organic animal husbandry

Organic farming is based on the idea of sustainability, environmentally friendly and nature-orientated farming. The definition for organic farming and the converting of organic products is based on a closed loop recycling management that should ensure the sustainability. High biodiversity in fields and meadows, minimized losses of nitrogen and CO_2-fixation through increase of humus are becoming necessary efforts in times of climate change. Their importance in the modern society is associated with the demand for organic products. Thus, the sustainable olive trees cultivation and olive oil production could be set as an example for organic farming.

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